Ultrasound of the Rotator Cuff: Technique, Pathology, and Pitfalls

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Rotator Cuff

Ultrasound Appearance:
- Tendon: hyperechoic, fibrillar
- Muscle: relatively hypoechoic
- Bone cortex: hyperechoic, shadowing

Technique: position #1
- Neutral, supination
  - Hand on lap, palm up
  - Anterior (10-17 MHz)
  - Biceps tendon:
    • Transverse, longitudinal

Long Head of Biceps Brachii Tendon

Note: Subacromial-subdeltoid Bursa (light blue)
Technique: position #2

- External Rotation
  - Anterior
  - 10-17 MHz linear
- Subscapularis tendon
  - Longitudinal, transverse
- Biceps dislocation

External Shoulder Rotation

Subscapularis

Technique: position #3

- Internal rotation, extension
  - Back of hand at other back pocket
  - Anterior (7-13 MHz linear)
- Supraspinatus
  - Start longitudinal
  - Infraspinatus

Neutral Position

Internal Rotation
Supraspinatus Tendon: normal
- Hyperechoic and fibrillar echotexture
- Convex superior surface
- Uniform thickness: transverse

Technical Considerations
- > 10 Mhz (prefer at least 12 Mhz)
- Supraspinatus: long axis most important plane
  - Less pitfalls, easy recognition of anatomy
  - >90% accuracy long axis alone
- Biceps tendon (intra-articular)
  - Important landmark: complete evaluation

1Arend CF et al. J Ultrasound Med 2010; 29:1725
Supraspinatus Tendon: distal

Long Axis

Short Axis (Greater Tuberosity)

Supraspinatus and Infraspinatus Tendons

Short Axis (Greater Tuberosity)

Supraspinatus and Infraspinatus Tendons

Short Axis

Supraspinatus – Infraspinatus Junction

Middle Facet: Infraspinatus overlaps supraspinatus

From: Chang EY et al. AJR 2014; 202:w376

Technique: position #4

- Neutral position
  - 10-17 MHz linear
  - Acromioclavicular joint
  - Subacromial-subdeltoid bursa
  - Dynamic: impingement

Subacromial-subdeltoid Bursa

Coronal

Acromion

Clavicle

AC Joint

Greater Tuberosity

Suprasp
**Impingement Test**

**Technique: position #5**
- Neutral position: posterior (5 – 12 MHz)
  - A. Posterior glenohumeral joint
    - Joint recess, infraspinatus
    - Labrum, spinoglenoid notch
  - B. Muscle atrophy
  - C. Suprascapular notch
    - Superior labrum

**Infraspinatus Tendon & Posterior Labrum**
- Infraspinatus: Long Axis
- No Atrophy (Short Axis, extended field-of-view)

**Suprascapular Notch and Superior Labrum**
- Coronal Plane

**Rotator Cuff Tears:**
- General comments
- Secondary signs of rotator cuff tear
- Pitfalls in rotator cuff sonography
Rotator Cuff Tear:

- Meta-analysis: 65 articles
- Full-thickness tears:
  - MRA, MRI, US = in sensitivity (92 – 95%)
  - MRA more specific
- Partial-thickness tears:
  - MRA most sensitive (86%) and specific
  - MRI (64%), US (67%)

Rotator Cuff Tears:

- Tears are hypoechoic / anechoic
- Indirect signs at ultrasound:
  - Cortical irregularity: supraspinatus footprint
    - If present on radiographs, 75% have tear
  - Volume loss
  - Massive tear: non-visualization

Rotator Cuff Abnormalities:

**Categories:**

- Partial-thickness tear
  - Articular-sided
  - Bursal-sided
  - Intrasubstance (or interstitial)
- Full-thickness tear
- Tendinosis

Supraspinatus: normal

Long Axis

Supraspinatus Insertion

From: Siebold et al.
RadioGraphics
1999; 19:685
Supraspinatus Tears: extent

- Rim-rent Tear
- Partial Articular
- Partial Bursal

From: Fundamentals of Musculoskeletal Ultrasound

Rotator Cuff Tear: Extent

- Partial-thickness:
  - Intersitial
  - Articular
  - Bursal

- Full-thickness, incomplete:
  - Extends to two surfaces

- Full-thickness, complete:
  - Entire tendon discontinuous
  - Full width

Articular Partial-thickness Tear: supraspinatus

- Long Axis
- Short Axis

Articular Partial-thickness Tear: supraspinatus

Long Axis
Coronal T2w

Pitfall Alert!
Anisotropy

- Sound beam oblique to tendon fibers
- Artifactually hypoechoic
- Most common location for this error: rim rent area

Supraspinatus: long axis
Bursal Partial-thickness Tear: supraspinatus

Full-thickness Tear: supraspinatus

Note: Cartilage Interface Sign (open arrow)

Full-thickness Tear: supraspinatus

T2w Coronal-oblique

T2w Sagittal-oblique
Large Full-thickness Tear: supraspinatus

Long Axis Short Axis

Chronic Full-thickness Tear: supraspinatus

1 year earlier

Intrasubstance Tear: supraspinatus

Long Axis

*Note: lack of cartilage interface sign


Tendinosis

- No inflammatory cells
  - Mucoid degeneration, chondroid metaplasia
- Hypoechoic, ill-defined
- Possible increased thickness
- No cortical irregularity*

*Radiology 2004; 233:234

Tendon Tear versus Tendinosis

*both may appear hypoechoic

Tear
- Anechoic
- Well-defined
- Homogeneous
- Thinned
- Bone irregularity*

Tendinosis
- Hypoechoic
- Ill-defined
- Heterogeneous
- Swollen
- Smooth cortex

*At supraspinatus tendon footprint in patients over 40 years old
Fatty Infiltration and Muscle Atrophy

• Supraspinatus and infraspinatus
  – Infraspinatus: only variable to predict cuff healing

• Associations:
  – Chronic, large, anterior supraspinatus tears

• Ultrasound:
  – Comparable to MRI
  – Improved reliability with extended field-of-view

2Hodler et al. Radiology 2005; 237:58
3Wall LB et al. JBJS 2012; 94:e83.
4Nazarian et al. 2008; 190.27.

Fatty Infiltration and Muscle Atrophy

• Indistinct tendon-muscle border
• Increased muscle echogenicity
  – Compared to teres minor
• Decreased muscle bulk
  – Compared to teres minor
  – Bone landmark: ridge in scapula
  – Short axis: infraspinatus 2x size

Infraspinatus Atrophy

Short Axis | Long Axis

Atrophy: supraspinatus and infraspinatus

Supraspinatus | Infraspinatus

Teres Minor

Short Axis (extended field-of-view)

No Atrophy

Teres Minor

Supraspinatus | Infraspinatus

Short Axis (extended field-of-view)

Rotator Cuff Tears:

• General comments
• Secondary signs of rotator cuff tear
• Pitfalls in rotator cuff sonography
Secondary Findings of Rotator Cuff Tears:

- Volume loss of tendon substance
- Cortical irregularity
- Effusion (articular & bursal)
- Cartilage interface sign

Tendon Volume Loss

Full-thickness Tear: supraspinatus

Cortical Irregularity:

- Greater tuberosity: at supraspinatus insertion
- When present: 75% have rotator cuff tears
  - Patient over 40 years old
- When absent: 96% normal cuffs by sonography

AJR 1998; 171:229
Radiology 2004; 230:234

Cortical Irregularity: no significance

Joint Effusion and Bursal Fluid

Subscapularis Tendon

Humerus

Deltoid
Small Full-thickness Tear: supraspinatus

Rotator Cuff Tears:
- General comments
- Secondary signs of rotator cuff tear
- Pitfalls in rotator cuff sonography

Anisotropy: supraspinatus

Improper Positioning: supraspinatus

Incomplete Evaluation of Supraspinatus
Musculotendinous Junction: supraspinatus

Bursal Thickening Simulating Intact Cuff

Pseudofibers with Full-thickness Tear

Miscellaneous Cuff Pathology:
- Infraspinatus tendon
- Subscapularis tendon
- Post-operative cuff

Infraspinatus Tear: full-thickness

Miscellaneous Cuff Pathology:
- Infraspinatus tendon
- Subscapularis tendon
- Post-operative cuff
Focal Full-thickness Tear: subscapularis

Subscapularis Tear: full-thickness

Miscellaneous Cuff Pathology:
- Infraspinatus tendon
- Subscapularis tendon
- Post-operative cuff

Post-operative Rotator Cuff:
- Post-op tendon: echogenic & thin*
- Reimplantation trough
- Echogenic sutures & anchors

Post-operative Rotator Cuff:
- Recurrent tear: usually large with nonvisualization
- Focal hypoechoogenicity: equivocal

*Mack et al. AJR 1988; 150:1089
Take-home Points

- Must follow a protocol
- Bone landmarks: greater tuberosity facets
  - Supraspinatus versus infraspinatus
- Cortical irregularity: important indirect sign
  - Supraspinatus tears
- Pitfalls:
  - Focal anisotropy simulating articular partial tear
  - Bursal partial tear: volume loss

Syllabus on line and other educational material:
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